Dockside Validation Methods for the Live-Market Red Sea Urchin Fishery in British Columbia

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ABSTRACT

Leus, D., Hajas, W., and Hand, C.M. 2012. Dockside validation methods for the live-market red sea urchin fishery in British Columbia. Can. Tech. Rep. Fish. Aquat. Sci. 3003: iv + 12 p.

Changes in world market demand for British Columbia red sea urchins (*Strongylocentrotus franciscanus*) have resulted in the development of a live market in addition to the traditional processed roe market. In order to accommodate the live market, the catch-validation protocol currently used for the traditional-commercial fishery needs to be updated to include methods to quantify red sea urchins that are transported while submersed in seawater.

Two new catch-validation methods are presented, where validated biomass is calculated as the product of (1) volume of submersed red sea urchins and an estimated mean biomass density of 16 lb/cu ft (95% confidence bounds of 15 and 18 lb/cu ft) or, (2) wet weight of red sea urchins freshly removed from water and the upper 95% confidence bound of a water-loss correction factor of 0.90 (mean of 0.87 and lower 95% confidence bound of 0.85). These two new validation methods would allow the validated weight of an urchin destined for the live market to count towards the same amount of quota as in the traditional-commercial fishery. Due to high variability in data, it is suggested that only a portion of a particular area's quota be validated using the new methods until further research can be done.

RÉSUMÉ

Leus, D., Hajas, W., and Hand, C.M. 2012. Dockside validation methods for the live-market red sea urchin fishery in British Columbia. Can. Tech. Rep. Fish. Aquat. Sci. 3003: iv + 12 p.

L'évolution de la demande du marché mondial en oursins rouges de la Colombie-Britannique (*Strongylocentrotus franciscanus*) a entraîné la création d'un marché de produits vivants parallèle au marché traditionnel des œufs transformés. Afin de répondre à la demande du marché des produits vivants, il est nécessaire de mettre à jour le protocole de validation des prises actuellement en vigueur pour la pêche traditionnelle commerciale, de sorte à inclure des méthodes permettant de quantifier les oursins rouges qui sont transportés alors qu'ils sont submergés dans l'eau de mer.

Nous présentons deux nouvelles méthodes de validation des prises, dans lesquelles la biomasse validée est calculée en tant que produit (1) du volume d'oursins rouges submergés et d'une densité moyenne de la biomasse estimée à 16 lb/pi^3 (limites de 15 et 18 lb/pi^3 de l'intervalle de confiance de 95 %) ou (2) du poids humide des oursins rouges fraîchement retirés de l'eau et de la limite supérieure de l'intervalle de confiance de 95 % d'un facteur de correction de la perte d'eau de 0,90 (moyenne de 0,87 et limite inférieure de 0,85 de l'intervalle de confiance de 95 %). Grâce à ces deux nouvelles méthodes de validation, le poids validé d'un oursin destiné au marché des produits vivants représenterait la même proportion du quota que dans la pêche traditionnelle commerciale. Compte tenu de la grande variabilité des données, nous suggérons de ne valider qu'une partie du quota d'une zone donnée à l'aide des nouvelles méthodes jusqu'à ce que des recherches approfondies soient réalisées.

INTRODUCTION

The British Columbia (BC) commercial red sea urchin (*Strongylocentrotus franciscanus*) fishery began in the 1970's with few controls. Landings and effort increased in the early 1980's and a series of management measures were implemented into the 1990's, including arbitrary quotas, licence limitation, individual quotas and a catch validation system (Campbell, 1998). In the validation process, catch is tallied against the assigned quota. Harvested product is currently validated by weighing it when it is first landed at the dock. Validated weights are an essential part of the quota program used to manage the BC commercial fishery and are used in-season to calculate quota remaining in individual quotas and area quotas.

Urchins landed for the processed market have typically been out of the water for a period of four or more hours by the time they are validated; therefore, validated weights should be considered drained weights. For consistency, estimates of urchin biomass (from which quotas are derived) are calculated from estimates of the weight of urchins that have drained for four to six hours. A mathematical equation, based on experimental data from urchins that had drained for a time comparable to that in the commercial fishery, is used to estimate drained weight from test diameters of sampled red urchins (Campbell, 1998). The fishery as described above will be referred to as the traditional-commercial fishery and the weight deducted from the quota is termed the validated biomass.

The BC commercial red sea urchin fishery has traditionally been geared towards a processed roe market. The urchins are processed in BC and the majority of the roe is shipped overseas to Japan. Annual landings have declined substantially in recent years due in most part to competition in the Japanese market from an Illegal, Unregulated and Unreported (IUU) red sea urchin fishery in Eastern Russia. In an attempt to revitalize a depressed market, the Pacific Urchin Harvesters Association (PUHA) has been developing markets for live, unprocessed red sea urchins in Europe, China, and locally via dockside sales.

The new live-market fishery requires urchins to be landed quickly in the freshest state possible, since mortality increases and quality decreases with drain time. Harvesters are testing new methods for maintaining high quality, live product including transporting urchins to the docks in totes full of water. Urchins landed for the traditional-commercial fishery lose weight after harvest as sea water drains from their outer body and as fluids drain from within their body. Urchins that are transported in sea water for the live market and validated immediately after being removed from sea water would weigh more and use up more quota than if they were landed after the usual length of drain time. In order to address this issue, new methods of validating urchins that are landed wet or that are landed submersed in sea water are needed for the in-season management of quota for the live-market fishery. One option is to simply use the un-drained weight as validated biomass, however quotas would be subscribed more quickly and some potential quota would be foregone. Alternatively, conversion factors could be developed to calculate a validated-biomass equivalent for landings of wet or submersed product.

A study was initiated at the request of commercial harvesters and fishery managers to develop a conversion from: 1) volume of submersed urchins to validated biomass and 2) wet weight to drained weight (validated biomass). The conversion is an aid to accommodate future live-market fishery landings of submersed red sea urchins into

the system of quotas developed for the traditional-commercial fishery. Using the conversion, the harvest of a red urchin will be counted against the same amount of quota whether it is sold on the live market or through the traditional-commercial fishery. This report presents the results of analyses of experimental data that were collected during fishery off-loads at Steveston Marina, south of Vancouver BC, where product containers are delivered for public dockside sales.

METHODS

DATA COLLECTION

For this study, vessels landing product in October and November of 2010 at Steveston Marina were requested to deliver their product submersed in totes full of sea water. On the vessel, harvested urchins were placed into totes already filled with water in order to prevent settling. Sea urchins were not out of the water for more than 5-10 minutes between the bottom of the ocean and the first tote weighing. Totes were landed completely filled with water and sea urchins; spines could protrude over the top but not tests.

After landing, the totes were labelled with a unique tag and a photo taken. The internal dimensions of each tote were measured to calculate the volume of the contained submersed urchins. A weight was taken with the tote full of water before the tote drain plugs were removed and the water allowed to drain. Once the water flow slowed to a drip, the plug was replaced and the weight measured at time *zero*. The weight at time *zero* will be referred to as the wet weight of urchins. The plug was removed for the next hour to allow water to drain, replaced and the tote was weighed again. Totes were weighed at one hour intervals, removing and replacing the plug, for a total of 16 hours. The totes were raised slightly at one end to prevent water from pooling in the tote bottom. All weight measurements used in analyses were tared to exclude weights of the tote, tote lid, weighing harness/bridal and freezer packs. Freezer packs were used to keep the urchins fresh during the study but are not expected to be used during the fishery. Other information collected includes location and date of harvest (to link to harvest log data), scale details, method of weighing (forklift vs. Hiab, hang scale vs. platform scale, etc), date, time, name of data collector, and weather during transit to port (urchins are likely to settle more during rough crossings).

ANALYSIS

Volume-Based Validation of Submersed Urchins

To standardize the different tote models used in this study and in the fishery, the term 'biomass density' was defined to express mass per volume, and calculated as:

Biomass Density (lbs/cu ft) = Drained Weight (lbs) / Submersed Urchin Volume (cu ft)

where drained weight is the tared weight of drained sea urchins at specific time intervals and submersed urchin volume is the tote volume calculated from the inner tote dimensions and assuming the tote is full of urchins. The biomass density approximately five hours after draining provides a measure compatible with the traditional-commercial

fishery. The product of mean, lower and upper 95% confidence bounds (CB) of this biomass density and the tote volume represents an estimate of mean validated biomass with 95% confidence bounds. The urchins were also weighed (validated) after approximately five hours of draining to allow a comparison between validated biomass estimated from biomass density and the actual scale-validated biomass. A two-tailed student's *t*-test was used to determine if mean biomass density differed between small and large totes.

Water-Loss Based Validation for Wet-Weight Urchins

A water-loss correction factor for quotas (F_Q) was calculated as the ratio of average drained weight at four, five and six hours to wet weight:

$$F_Q = (W_{t4}+W_{t5}+W_{t6})/3]/\text{Wet Weight}$$

where W_{t4}, W_{t5} and W_{t6} are the tote weights approximately four, five and six hours post draining and wet weight is the tote weight within a few minutes of being drained. Mean, lower and upper 95% CB for F_Q were calculated for small, large and all totes combined. A two-tailed student's *t*-test was used to determine if F_Q differed significantly between small and large totes.

Validated biomass was calculated as the product of wet weight and the mean and 95% CB of the water-loss correction factor. Estimates of validated biomass were evaluated against the scale-validated biomass for the same sample of totes by applying the water-loss correction factor (F_Q) to wet weights for individual tote samples.

RESULTS

A total of 15 totes from eight different tote models, varying in volume and dimensions, were sampled for changes in red sea urchin biomass density with time. Of the 15 samples measured, data from three samples were excluded from the volume-based validation analyses due to incomplete data. Exclusion of these data reduced the number of tote models sampled from eight to five.

Tote volume ranged from 8.5 to 38.0 cubic feet and is considered representative of the majority of totes used by the red sea urchin commercial fishery (Table 1). Generally, urchin biomass density varied between totes with a range of 11-24 lbs/cu ft. The rate of decrease in urchin biomass density with time was similar (Figure 1).

VOLUME-BASED VALIDATION FOR SUBMERSED URCHINS

The scale-validated biomass averaged 325 lb for the 12 totes and ranged from 114 lb to 657 lb (Table 1). The mean biomass density for submersed red sea urchins for small totes approximately five hours after removal from water was 17 lb/cu ft with 95% CB of 14 and 19 lb/cu ft. For large totes, the mean was 16 lb/cu ft, with 95% CB of 15 and 17 lb/cu ft. Small totes showed more variability in biomass density compared to large totes. A student's *t*-test on mean biomass density for small and large totes indicated a lack of

statistical difference between these samples ($p>0.05$). The overall mean biomass density was 16 lb/cu ft, with 95% CB of 15 and 18 lb/cu ft.

Using the overall mean and 95% CB of biomass density of 15, 16 and 18lb/cu ft to calculate volume-based validated biomass results in an average of 27 lb (8%) and 7 lb (2%) underestimation of weight, and 33 lbs (10%) overestimation of weight per tote, respectively, compared to the measured scale-validated biomass at approximately five hours after removal from water.

WATER-LOSS BASED VALIDATION FOR WET-WEIGHT URCHINS

The water-loss correction factor (F_Q), four to six hours after draining, ranged from 0.95 to 0.76, representing a 5% to 24% decrease in weight attributed to water loss (Table 2a). Small totes had a mean water-loss correction factor of 0.85 with lower and upper 95% CB of 0.80 and 0.89, while large totes had a mean of 0.89 (95% CB of 0.87 and 0.91). A student's t-test for differences in F_Q for small and large totes indicated a lack of statistical difference in these samples ($p>0.05$). Overall, the mean water-loss correction factor for all totes was 0.87 with 95% CB of 0.85 and 0.90 (Table 2b).

Red sea urchin weights continued to decrease beyond the six hour mark until the end of observations at the 16 hour mark (Table 3, Figure 2). Data for four of the 15 samples were not collected after the 15 hour mark, decreasing the sample size to 11. A water-loss correction factor (F_t) was determined for any time (t) as the change in the ratio of drained weight to wet weight over time. The results were graphed (Figure 2) and fit to a quadratic curve with the intercept fixed at one. The fitted curve can be expressed with the formula:

$$F_t = 0.0009t^2 - 0.0293t + 1$$

where F_t is the ratio of drained weight to wet weight and t is the drain time in hours. The R^2 value for this formula was 0.98.

The mean wet weight for all totes was 420 lb while the mean validated biomass was 371 lb (Table 4). Applying a water-loss correction factor to wet weight of 0.85, 0.87 and 0.90 (the lower, mean and upper 95% CB for all totes) produced mean corrected wet weight estimates of 357 lb, 365 lb and 378 lb. Using a water loss correction factor of 0.85 or 0.87 results in an average underestimation of scale-validated biomass of 14 lb (4%) and 6 lb (2%) for this sample of totes (too little quota would be deducted). Using a water loss correction factor of 0.90 would result in an overestimation of validated biomass by 7 lb (2%).

DISCUSSION

The proposed volume based and water-loss based validation methods are intended to accommodate a new and developing market for live- or wet-landed red sea urchins in BC. This new segment of the fishery is a departure from practices in the traditional-commercial fishery as it involves the transportation of urchins submersed in sea water to the point of validation. The purpose of this study is to develop a means to convert the volume of submersed product or the weight or freshly-drained red sea urchins into a validated biomass equivalent for in-season management of the commercial fishery.

For urchins that are landed submersed in water, the validated biomass can be calculated with a conversion based on biomass density and an estimate of the volume of landed urchins. The proposed validation process would eliminate the need to weigh urchins. Use of the more precautionary upper 95% CB for mean biomass-density (18 lb/cubic foot) resulted in an overestimate of validated weight by 10% for the sampled totes in this study. Alternatively, using the mean biomass-density of 16 lb/cu ft is less precautionary but it compares closely (2% underestimation) to measured validated weights.

The volume-based validation method uses biomass densities that are based on standard fishing totes of urchins that have not been subject to settling after being drained. There may be greater packing down of urchins if a boat loads a tote while it is not full of water, or if the boat travels through rough weather with a tote full of submersed urchins. Validators may wish to spot check immersed-landed loads of urchins for settling. In this case, biomass density may be higher than the estimate of 16 lb/cu ft and validated biomass underestimated. This would be less precautionary.

Industry has expressed interest in packing urchins in cages or trays to transport submersed product in order to reduce spine breakage and improve the aesthetic quality. The water-loss correction factor may provide greater flexibility when product is kept submersed until the point of landing, is removed from water and immediately weighed and re-submersed. A water loss correction factor, F_Q, is proposed to convert wet weights to validated biomass. Applying a 10% weight correction to the sampled totes results in a small (2%) overestimation of validated biomass.

Continued weight loss was observed in urchins with increased drain time. Samples of urchins draining for 10 or more hours were significantly lighter than samples of urchins used to derive quota biomass calculations. It is unknown whether longer-term weight loss is due to continued dripping of sea water off the tests, or draining of body fluids from within the tests. Fishermen report that the number of floating urchins when placed back into water increases with draining time, even after just a few minutes. This suggests body fluids may start draining out as early as a few minutes after removal from water in some urchins. Fishermen continue to assert their belief that the fluids draining from urchins beyond the six hour mark is sea water and so should not be counted against quotas. Further research on the proportion of sea water to bodily fluids draining off red sea urchins with respect to time would be required to confirm this belief.

Time and financial constraints restricted sample size, with results showing large (54%) variability in urchin biomass density among the totes. Although not statistically different, results suggest that density may be affected by the general size of tote. A narrowing of confidence bounds, and possibly a conversion more favourable for Industry, is expected if Industry were to standardize to a single tote model and/or more samples are collected. With the information at hand, it may be advisable to impose a precautionary limit on the amount of landed catch that is validated with the volume based or water-loss based validation methods in any given management area.

The urchins sampled in this research were destined for local live market sales. The effect of the size range of urchins was not determined in this research and so it is assumed that the size range sampled is either representative of future urchins validated using the proposed methods, or that size range has an insignificant effect. A change in market demands or legal size limits may affect the biomass-density estimates. The variety of totes used to sample urchins is also thought to be representative of those to be used for

live-market validation. The influence on validated biomass of the use of totes outside of the sampled size range is unknown. Another factor that may influence urchin density is packing down of urchins, for example during travel through rough weather. In this case, biomass density would be higher and landed weight would be underestimated and less precautionary.

ACKNOWLEDGEMENTS

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Table 1. Comparison of scale-validated biomass and estimated validated biomass of red sea urchins calculated from tote volume and estimated mean, lower and upper 95% confidence bounds of biomass density at five hours of draining, and the difference between the estimates. Lower case tote sample letters represent small totes while upper case represents large totes.

	Measured Data			Estimated Data			Difference		
		Scale	Biomass-	Validated Biomass (lb)			Scale minus Estimated (lb)		
Tote Sample	Tote Volume (cu ft)	Validated Biomass (lb)	Density at ~5hrs (lb/cu ft)	LCB @15lbs RSU/cu ft	Mean @16lbs RSU/cu ft	UCB @18lbs RSU/cu ft	LCB @15 lb RSU/cu ft	Mean @16lbs RSU/cu ft	UCB @18lbs RSU/cu ft
a	8.5	154	18	128	136	153	27	18	1
b	8.5	162	19	128	136	153	35	26	9
c	8.5	166	20	128	136	153	39	30	13
d	9.0	114	13	135	144	162	-21	-30	-48
e	9.0	129	14	135	144	162	-6	-15	-33
F	26.1	402	15	392	418	470	11	-16	-68
G	26.1	423	16	392	418	470	32	5	-47
H	26.1	433	17	392	418	470	42	15	-37
I	26.1	451	17	392	418	470	60	33	-19
J	26.1	460	18	392	418	470	69	42	-10
K	26.2	346	13	393	419	472	-47	-73	-126
L	38.0	657	17	570	608	684	87	49	-27
Mean:	**19.9**	**325**	**16**	**298**	**318**	**357**	**27**	**7**	**-33**

Table 2a. Water loss correction factor (F_Q) calculated as the ratio of mean drained weight of red sea urchins at four to six hours post draining, to wet weight. Lower case tote sample letters represent small totes while upper case represents large totes.

Tote Sample	Mean Drained Weight, 4-6hr (lbs)	Wet Weight (lbs)	F_Q
a	153	201	0.76
b	162	182	0.89
c	167	191	0.87
d	115	139	0.83
e	130	147	0.88
F	402	469	0.86
G	418	481	0.87
H	434	505	0.86
I	451	491	0.92
J	456	489	0.93
K	347	380	0.91
L	656	743	0.88
M	498	584	0.85
N	570	662	0.86
O	602	636	0.95

Table 2b. Mean, lower and upper 95% confidence bounds for the water loss correction factor (F_Q) for small, large and all totes.

Sample	Tote Size	Water Loss Correction Factor F_Q		
		LCB	Mean	UCB
a-e	Small	0.80	0.85	0.89
F-O	Large	0.87	0.89	0.91
a-O	**All**	**0.85**	**0.87**	**0.90**

Table 3. Ratio of drained weight to wet weight of red sea urchins for all tote samples combined, with lower (LCB) and upper (UCB) 95% confidence bounds. The weight of urchins used to calculate biomass and quotas is based on drain times of four to six hours, indicated in bold.

Drain Time (hr)	Sample Size (n)	Drained Weight:Wet Weight		
		LCB	Mean	UCB
0	15	1	1	1
1	15	0.94	0.95	0.97
2	15	0.90	0.92	0.94
3	15	0.88	0.91	0.93
4	**15**	**0.87**	**0.89**	**0.91**
5	**15**	**0.85**	**0.87**	**0.90**
6	**15**	**0.83**	**0.86**	**0.88**
7	15	0.82	0.84	0.87
8	15	0.80	0.83	0.86
9	15	0.79	0.82	0.85
10	15	0.78	0.81	0.83
11	15	0.77	0.80	0.83
12	15	0.76	0.79	0.82
13	15	0.75	0.78	0.81
14	15	0.74	0.77	0.80
15	15	0.73	0.76	0.79
16	11	0.73	0.76	0.80

Table 4. Comparison of scale-validated red sea urchin biomass to estimated validated biomass as calculated from the mean, lower and upper 95% confidence bounds for the water-loss correction factor F_Q, and the difference between the estimates. Lower case tote sample letters represent small totes while upper case represents large totes.

Tote Sample	Wet Weight (lb)	Scale-Validated Biomass (lb)	Estimated Validated Biomass (lb) using Water-Loss Correction Factor:			Difference (lb) Scale minus Estimated		
			$F_Q = 0.85$	$F_Q = 0.87$	$F_Q = 0.90$	$F_Q = 0.85$	$F_Q = 0.87$	$F_Q = 0.90$
a	201	154	171	175	181	-17	-21	-27
b	182	162	155	158	164	7	4	-2
c	191	166	162	166	172	4	0	-6
d	139	114	118	121	125	-4	-7	-11
e	147	129	125	128	132	4	1	-3
F	469	402	399	408	422	3	-6	-20
G	481	423	409	418	433	14	5	-10
H	505	433	429	439	455	4	-6	-22
I	491	451	417	427	442	34	24	9
J	489	460	416	425	440	44	35	20
K	380	346	323	331	342	23	15	4
L	743	657	632	646	669	25	11	-12
M	584	497	496	508	526	1	-11	-29
N	662	568	563	576	596	5	-8	-28
O	636	602	541	553	572	61	49	30
Mean:	**420**	**371**	**357**	**365**	**378**	**14**	**6**	**-7**

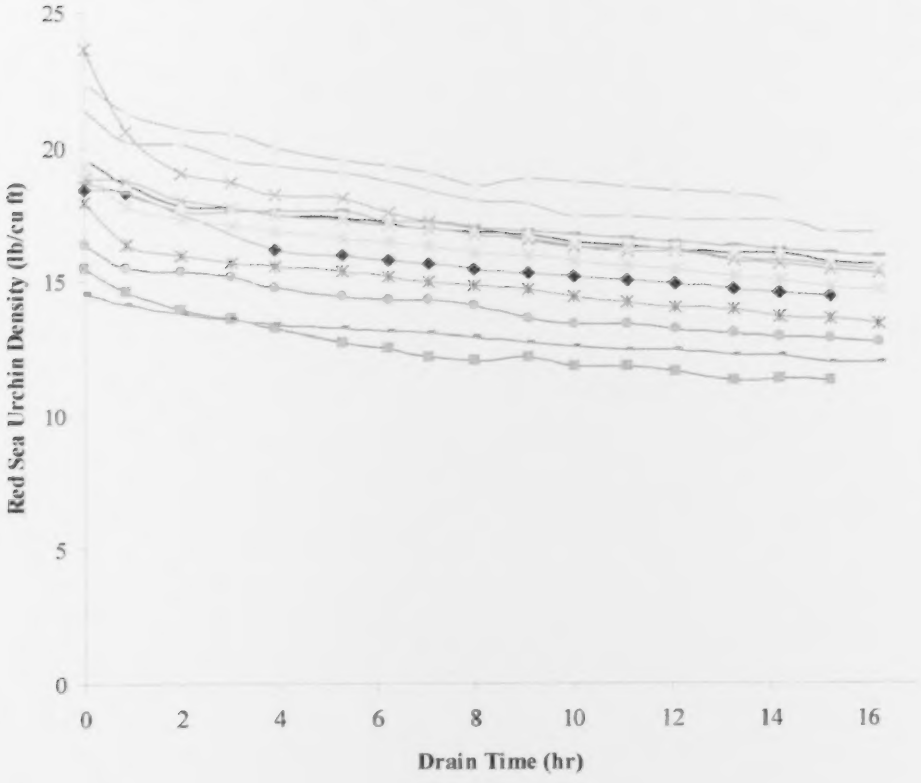

Figure 1. Change in red sea urchin biomass density (lb/cu ft) with drain time (hr), by tote sample, for urchins submersed in sea water at the time of landing.

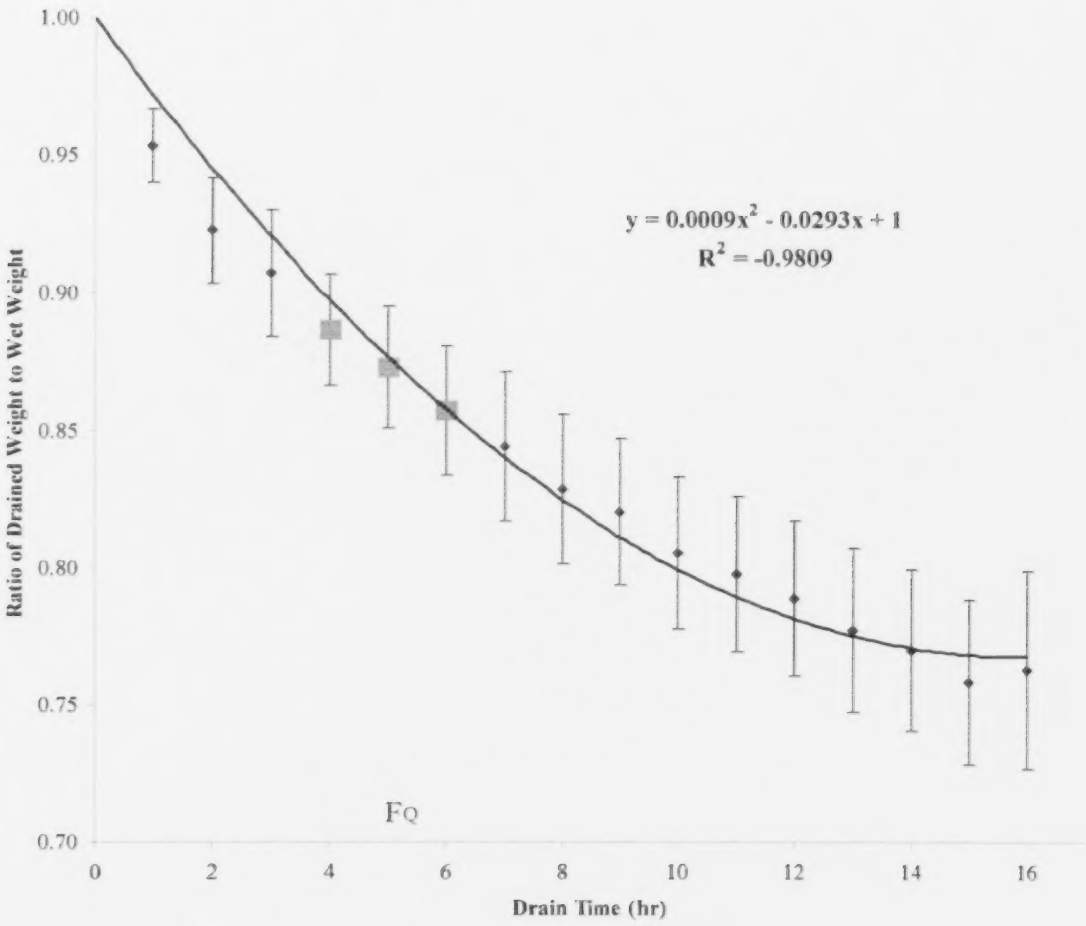

Figure 2. Ratio of red sea urchin mean drained weight to mean wet weight with time (hr) for totes sampled at Steveston, BC (n=15). Error bars indicate upper and lower 95% confidence bounds. Squares indicate the time frame for drained-weight estimates used to estimate water-loss correction factor, F_Q.